JOURNAL

AUGUST, 1932

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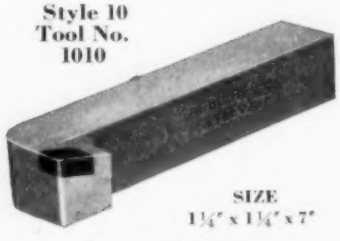

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A. S. T. E. Journal

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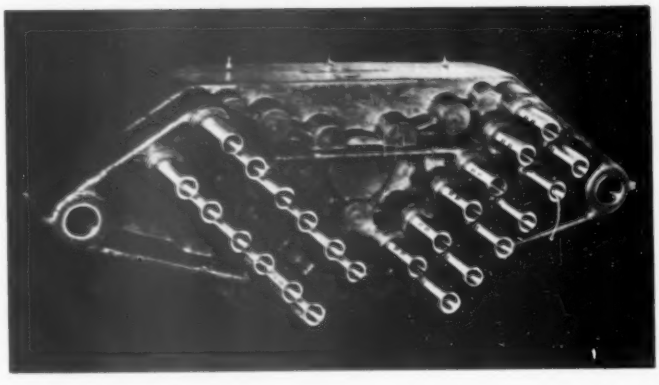

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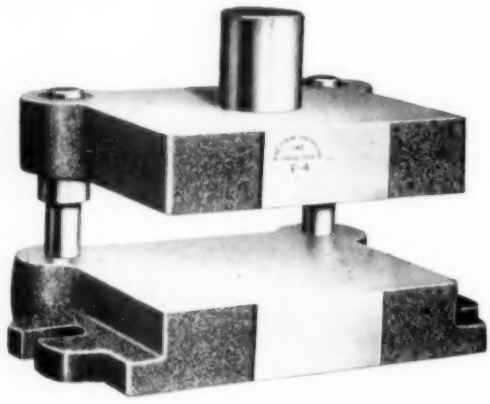

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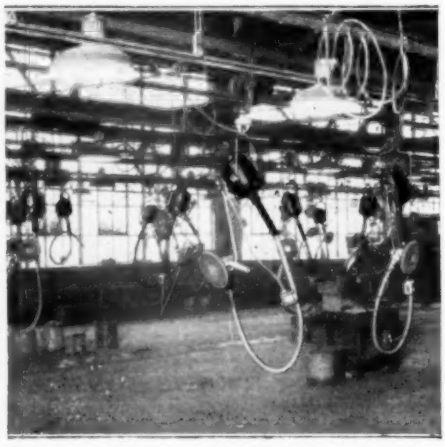

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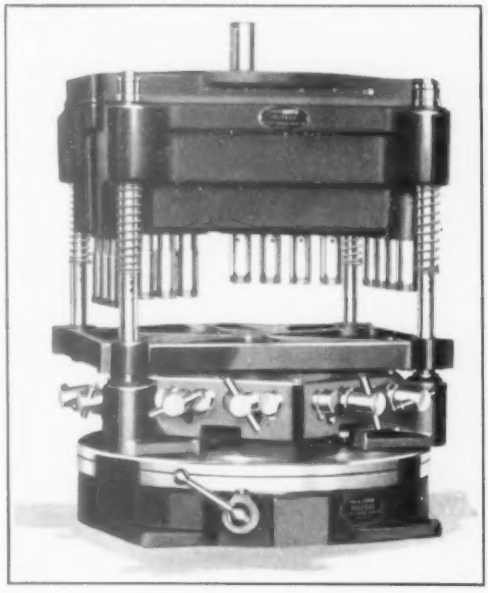

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Announcement

By action of the Board of Directors it was decided to offer, as a special inducement during our present membership drive, to admit new members upon the payment of $3.00, the regular initiation fee.

No dues will be required for the balance of the year 1932, providing the application is filed during this drive for members.

We have set 1000 members as our goal for the year 1932, and ask every member to notify all prospective members of this action.

We believe that no better investment of $3.00 could be made by Tool Engineers than the purchase of a membership in the American Society of Tool Engineers.

MEMBERSHIP COMMITTEE.

The Tool Engineers Vacation

1932—Gone are the days

Albert Collins has built a combination utility and camping trailer which seems to have considerable commercial possibility, as it has several original and desirable features, and could be manufactured at an extremely low cost. He recently tried it out on a week's trip around Lake Michigan, and reports it satisfactory in every respect.

Bill Buswinka was reading last month's copy of the Journal, when he came upon the following excerpt from the Magazine of Wall Street:

"This is the Law:

Live cleanly.
Eat wisely.
Sleep adequately.
Exercise regularly.
Study methodically.
Save systematically.
Invest judiciously.

"So—and only so—may you attain health, wealth, and wisdom—"

"Well," observed Bill, "if that's the law, we Tool Engineers are outlaws. That may be enough to get by on, in Wall Street, but most of us, at least once in a while, have to WORK also.

NO GENERAL MEETING IN AUGUST

There will be no general meeting in August. The Tool Engineers voted at the last meeting to cancel the August general meeting because of vacations and hot weather.

The next general meeting of THE AMERICAN SOCIETY OF TOOL ENGINEERS will be held the second Thursday in September. The September issue of this Journal will carry the announcement of time and place.

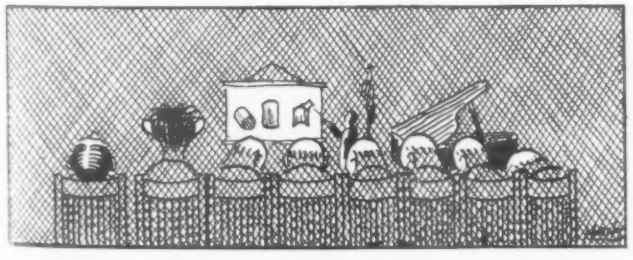
REPORT OF LAST MEETING

HELD JULY 14, 1932, AT DETROIT LELAND HOTEL

The surprise speaker promised by the Meetings Committee for this meeting was a surprise indeed. Alfred Lawson, the surprise speaker, spoke on "Direct Credits for Everybody," and we admit that this subject was entirely new to us.

My Impressions from where I sat.

We had some lecture.



And then we had some more lecture.

We did not know anything about "Direct Credits for Everybody" before the meeting, and we knew very little more about the subject after the meeting. Several of Mr. Lawson's statements sounded good the first time stated, but we were inclined to urge him to proceed with his exposition. We heard him the first time. No doubt his method of delivery would go good on a soap box in the park, but constant repetition was unnecessary with that audience. The thought still lingers in our mind, that if he gauged his method of delivery to his analysis of the capacity of his audience, it was not very complimentary to the Tool Engineers.

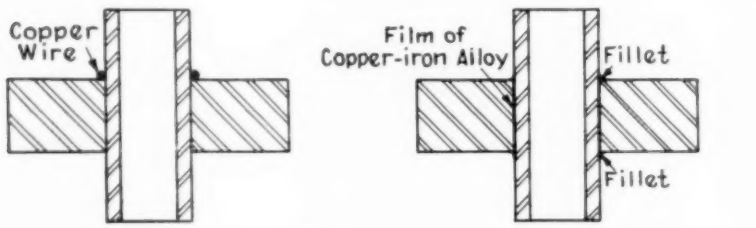
It should be distinctly understood that THE AMERICAN SOCIETY OF TOOL ENGINEERS does not recommend "Direct Credits for Everybody" as a solution for our present conditions, but if the subject gave you something to think about entirely divorced from Tool Engineering, it should have been somewhat of a mental recreation, and the Meetings Committee have accomplished their purpose.

Mr. Lawson said little about the actual plan he proposes as a cure for our depression, and we find that his booklet says very little about the working out of his plan. Perhaps, as he says, it is difficult to do one-hundred-billion dollars volume of business with only five-billion dollars of actual money. Perhaps the production of gold has not kept pace with the expansion of business volume. Perhaps we do not need gold as the basis of our monetary system, but before we throw it away we want a workable solution as an alternative. Mr. Lawson did not seem inclined to go into details about his plan, but we believe the Tool Engineers would have picked the meat out of it had he permitted them to do so.

WHAT TOOL ENGINEERS SHOULD KNOW ABOUT HYDROGEN BRAZING

By B. E. MESSER, B.S.E.E., General Electric Company

Copper Brazing, a process for fabricating steel parts in furnaces with controlled reducing atmospheres, was first developed in the General Electric laboratories. In its present form, this method represents the development of several years, and the combination of many operations and principles known previously and applied in other ways. Its practicability was so obvious that it was immediately employed in the manufacture of turbines, refrigerators, and other apparatus. Several years of successful operations have shown clearly that parts united by this process are free from localized strains, that often accompany the more familiar forms of brazing, and at the same time compare very favorably in strength, tightness, and appearance with those united by other methods. Many parts having several joints can be completely united by one passage through a furnace having proper control of atmosphere and temperature. The union of the parts is a natural sequence of capillarity and metallic solutions.



A. Object prepared for copper brazing. Ring of copper wire adjacent to clean, tight joint.

B. Same object as shown in "A". Copper brazed in hydrogen electric furnace. Temperature 2100°F. (1150°C). Copper flowed into joint by capillary attraction, forming metallic solutions.

Fig. 1

The process may perhaps be most easily understood by making certain comparisons with brazing. As is well known, the latter consists of welding with brass or bronze; fluxed surfaces are joined with a thin layer of alloy. Brazing can be done in several ways—either by dipping the assembly into a pot of molten metal, by sprinkling granular metal or spelter in the joint and heating locally, or by the familiar method of oxy-acetylene welding, using brass or bronze welding rod and suitable flux. But in any of these modifications the principle is the same; namely, if the steel or iron is clean and hot, melted brass will run over it in a very thin film, "wetting" the metal and forming a strong alloy with the surface in contact. The chief difficulty encountered by these methods, however, is that localized heating confines the flow of the brazing metal to the unoxidized, clean and hot portions of the steel. Localized heating also sets up strains, that sometimes may be of serious consequences, and the appearance is so injured that subsequent cleaning is usually necessary. Even though surfaces are clean to begin with, fluxes must be used to reduce oxides formed under the heat; these fluxes and oxides, while ordinarily not harmful, leave joints of untidy appearance.

Pure copper as a brazing material was known to have extraordinary power to penetrate between finished steel surfaces fitted together. In addition, it was found while studying coarse-grain silicon steel in the laboratory several years ago, that molten copper would penetrate far into the steel between the metallic crystals, or along the grain boundaries. Hot copper at the melting point, however, absorbs oxygen from the air very readily, and consequently brazing with pure copper would have to be done in an atmosphere free from oxygen. Very well, fill the furnace with hydrogen, which will not only exclude the air, but will also react with any iron oxide on the steel, and perform the essential function of a flux, as well as brighten the surfaces.

The ready commercial development of successful copper brazing furnaces was due, in part, to the fact that the General Electric Company had been annealing quantities of transformer sheets and magnetic irons in hydrogen atmosphere furnaces for several years. Consequently, such problems as the production of hydrogen; the prevention of hydrogen fires or explosions; the making of tight furnace casings, and the proper methods of control, had already been successfully dealt with.

What It Is and What it Requires

It is known that a copper-iron alloy is formed on iron surfaces at the brazing temperature of 2100° F. This alloy is only "skin deep," consisting of approximately 3 per cent. copper and 97 per cent. iron; gives the copper a good bond with the iron, and provides a strength far greater than would be obtained by merely "pasting" two surfaces together with a suitable filler. This attraction of iron for copper is responsible for the flow of molten copper upon hot

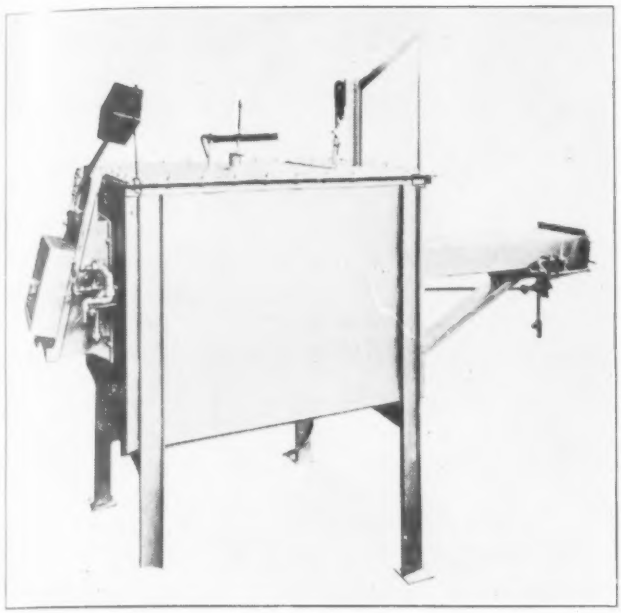


Fig. 2

iron surfaces. This flow is not appreciable on cold surfaces as evidenced by the fact that spelter does not run into torch-brazed joints beyond the localized hot area. This uniform flow through evenly heated joints extends into the grain boundaries of the iron, forming a grip that is not readily released.

In addition to the affinity of iron for copper there is also an affinity of copper for iron as evidenced by the dissolving and eating away of iron stirring rods in pots of molten copper considerably below the melting point of iron. At 2100° F. copper holds between 3 and 4 per cent. of iron in solution. This alloy forms within the joints, and is retained upon "freezing" of the metal. It is stronger than pure copper, and will form quickly in tight joints containing only a thin film of copper.

Capillary attraction comes into play quite prominently in a copper braze, since the consistency of the copper at brazing temperature is about that of kerosene. In a joint that is clean and tight the copper will be drawn upward as well as downward by surface tension, in a manner similar to that in which water climbs in a small capillary tube.

First, the metal to be brazed should be clean, so the copper will wet it. The hydrogen atmosphere maintained within a brazing furnace cleans some oxide film and some impurities from iron surfaces, giving excellent conditions for a braze, and, if the piece is cooled in hydrogen, gives it an attractive clean appearance when removed from the cooler. Heavy oxide scale or the lead skin often present on cold rolled stock must be removed from surfaces of steel at joints to be brazed by grinding, shot blasting, or some similar manner, because hydrogen will not remove such material.

Second, the joint should be fairly tight to take advantage of the available capillary attraction. The maximum tolerance for a gap in a joint has been found to be about .003 in. Within this limit the capillary force may be depended upon to draw the copper into the joint, and the film will be transformed into the copper-iron alloy by diffusion of iron into the copper. Beyond this tolerance difficulty is sometimes encountered in getting the copper to flow into and remain in the joint upon cooling. There is also the probability that, if the copper does remain in the joint, it will freeze only as pure copper with only the strength of cast copper.

In contrast with this, it has been found that joints cannot be made too tight for the copper to flow into them, because as the tightness increases, the flow of copper increases. These were found to be the strongest pieces in test, and hence it is desirable to assemble with press fits wherever possible.

Another phenomenon that imparts strength to a copper-brazed joint is the tendency for the grains of steel to grow together across the joint. Two pieces of ordinary steel with machined surfaces allowed to rest together under pressure for a year of two, will sometimes become stuck together by a growth

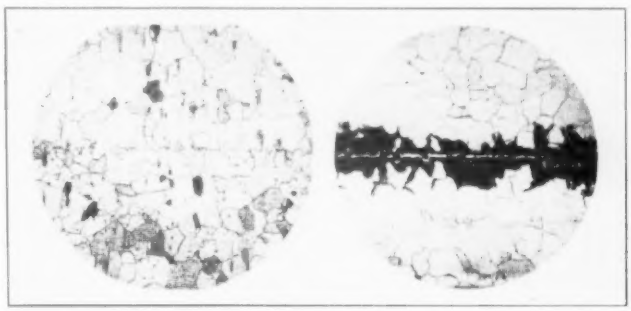


Fig. 3

of the grains at the contact surfaces. If these two pieces under pressure are sent through a furnace at 2100° F. without copper the joints will practically disappear because of grain growth. Upon pulling, the joint will break apart, however, because it does not have the strength of the parent body.

This action of grain growth can be approached by the addition of molten copper into the hot joint, without external pressure. In general, it may be

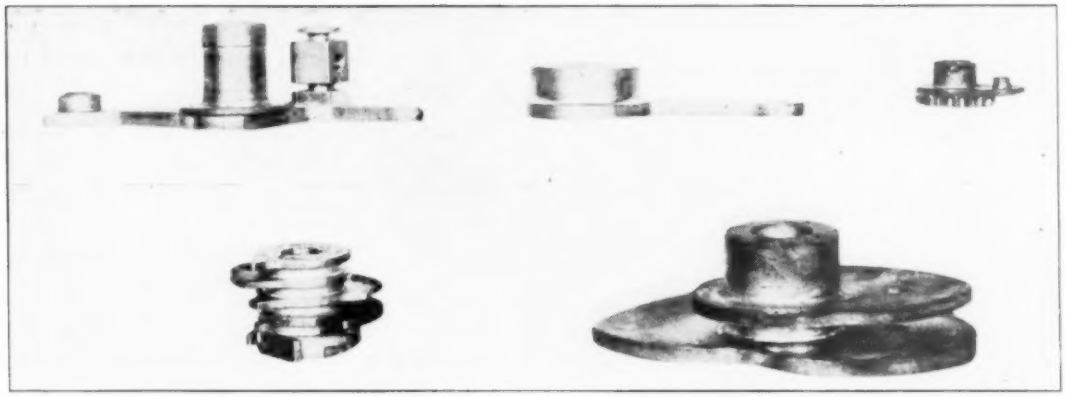


Fig. 4

said that a correctly brazed piece will have a strength in the joint of about double that of copper.

Summarizing, there are four effects that take place to impart strength to a copper-brazed joint; the alloying of copper with iron, the alloying of iron with copper, the penetration of copper along the grain boundaries of the steel, and the grain growth across the joint. The accumulation of these effects produces a union that, in most cases, will be as strong as the steel itself.

Effect of Temperature and Atmosphere on Steel

Because of the relatively high temperatures used in copper-brazing, a rather coarse grain structure is produced in the steel, but the parts are dead-annealed and ductile, a most favorable condition generally.

The hydrogen atmosphere has no embrittling effect, as produced by nascent hydrogen when pickling in sulphuric acid, because the hydrogen is molecular and stable. However, there is a de-carbonizing effect on the surface if sections are heavy and require long heating in brazing. With low-carbon steels this is of no consequence, and in most instances with carbonized and high-carbon pieces this de-carbonized skin can easily be ground off, leaving metal at the surface with the original carbon content.

Metals Suitable and Unsuitable

In general, most of the ferrous metals can be brazed in hydrogen with very satisfactory results. In this group are low-carbon steel, high-carbon steel, carburized steel, and high speed steel. The stainless steels containing chromium will not braze because their stainless property is due to a surface film of chromium oxide, which is not reduced by commercial hydrogen, hence the surfaces cannot be satisfactorily cleaned to allow for the flow of copper. Chromium, aluminum, and silicon are all offenders in this manner. If the chromium contained does not exceed about one-half of one per cent., the metal will braze satisfactorily, but larger percentages of chromium present serious difficulties which can only be overcome with a solvent borax flux. Large amounts of chromium render the brazing process commercially impractical.

Nickel and copper have a strong affinity for one another, and little trouble is encountered in brazing steels of low nickel content. With high nickel content, however, it is sometimes difficult for the copper to flow very far into the joints, because it is absorbed by the nickel faster than it can travel on the surface of the metal, and also because the diffusion of nickel into the copper raises the melting point of the alloy, causing solidification. In some cases this can be overcome by placing the copper into the joint before brazing.

Fig. 5

Tungsten, molybdenum, and tungsten-carbide alloy braze satisfactorily, as evidenced by the fact that Carboloy tools are fabricated in this manner.

Gray cast iron has been copper-brazed in the laboratory, but the most satisfactory results have been obtained by heating the material in air to oxidize the surface, and then reducing this oxide in a hydrogen atmosphere before brazing. Copper-brazing of gray cast iron has also been satisfactorily done by

using cryolite as a flux. Copper-brazing of malleable iron is more easily accomplished because of the wider range of temperature over which the operation can be carried out.

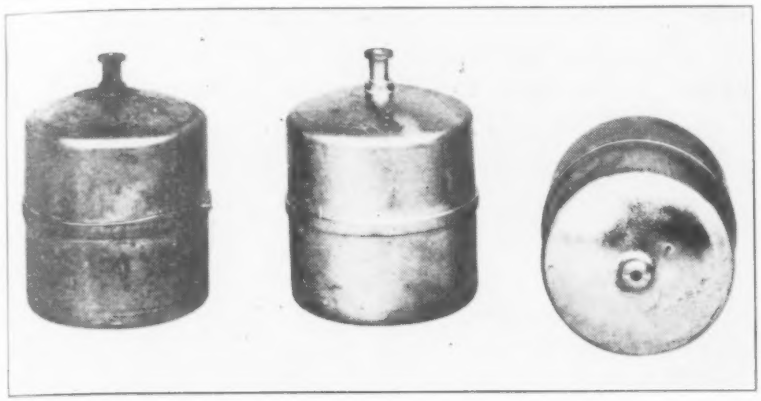


Fig. 6

Forms of Copper Used

Copper is usually placed near the joints to be brazed during the assembly of parts, and can be applied in any convenient form, such as wire, chips, ribbon, powder, or paste.

A satisfactory copper paste can be made up for painting around joints by mixing pure copper powder with pyroxylin and thinner. This method is somewhat more expensive than others, but also, in many cases, is more convenient.

Use of Copper Alloys

Since the copper brazing temperature is rather high and presents special problems in the design of furnaces and supports for the work, the question frequently arises as to why copper alloys with low melting points cannot be used with equally good results. In general, the use of such allows is not practicable. Copper alloys containing zinc are particularly injurious because the zinc volatilizes readily, contaminating the furnace atmosphere, and condensing in the brick work and cooling chamber. Necessity of removing the brick work and scraping the shell gives an ultimate consequence. Perhaps the greatest disadvantage of using such an alloy, however, is an inability to control its melting point. As the zinc boils away, the melting point of the alloy rises, and the alloy will solidify if a higher temperature is not maintained. Increasing the furnace temperature causes this procedure to be repeated until eventually a point is reached when nothing but pure copper is left, requiring a temperature of 2100° F. for best flowing conditions.

Lead is also an enemy to the copper brazing process, because it volatilizes readily, and traces of it in the furnace atmosphere play havoc with the possibilities of obtaining a good braze.

Tin in an alloy with copper does not volatilize readily, but does render the molten alloy less fluid than pure copper. Embrittlement in the joint is also a noticeable characteristic, which, of course, impairs strength.

Some of the above undesirable effects are present with most low-melting metals, and since pure copper gives such uniformly good results, its use is recommended in all cases.

Confining Copper Flow

Occasionally it is desired to confine the flow of copper within certain areas to prevent its accumulation in machined sections, such as threads, holes, etc. The most popular and least expensive method of accomplishing this is by the use of whiting or chalk, which, when mixed with water, can very conveniently be applied with a small brush. Copper does not wet its surface, with the result that the whiting becomes a barrier to the flow of molten copper. After removal from the furnace, this whiting can be very easily removed with a stiff brush, leaving a clean, shiny surface untouched by copper.

Subsequent Operations

Processes subsequent to brazing sometimes require the copper adjacent to the joints to be removed from the surface of the mental before additional production operations are performed. Use of a bath of ammonium nitrate solution solves this problem satisfactorily, and the amount of copper removed is dependent upon the strength of the solution and the length of time in the bath.

Although it might appear practicable to obtain a uniform corrosion-resisting film of copper over the surfaces of the steel simultaneously with the braze, it has been found that such a coating cannot be obtained without occasional bare spots, and without a penetration of steel grains through the thin copper film on the outer surface. The copper film should not be depended upon for protection of the steel.

Applications and Misapplications of Copper-Brazing

In general, pieces that are assembled for copper-brazing should have tight fits, so that they are self-supporting, and require no supports for holding the

separate parts together while passing through the furnace. In choosing possible applications for copper-brazing, care should be taken to see that the work has this feature. Tack welding is frequently an invaluable aid in this respect. It should be understood that copper-brazing, like heat treating, is a process which gives quality to a product. Its value must be considered by taking into account the advantages derived from its use. For instance, parts

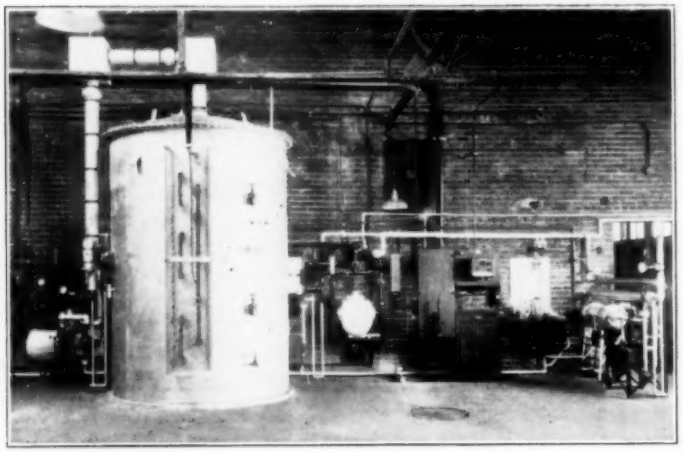


Fig. 7

that can be spot welded inexpensively and do not require strength or a continuous tight joint are not ordinarily brazed. Riveting, flash welding, arc welding, and atomic hydrogen welding present, in many instances, cost advantages over copper-brazing, either from the standpoints of operation, initial investment, or both; but, when several joints are to be made into one piece, copper brazing frequently becomes a cheaper process to use. Also, as soon as appearance becomes important, or gas tightness, cleanliness, strength at the joint, or an annealed condition at the joint, rather than embrittlement, becomes desirable, copper-brazing should be considered.

Furnace Atmospheres

In view of the expense involved in the purchase of tanked hydrogen, and the high cost of small hydrogen generating plants, new apparatus has been developed for producing suitable gases for copper-brazing furnace atmospheres at a low operating cost and a low initial cost. One process is the dissociation of anhydrous ammonia, and the other consists in reforming hydro-carbon gases, such as city gas. It is not necessary that copper brazing atmospheres be pure hydrogen, although it is essential that they have reducing properties. Nitrogen, being an inert gas, acts only as a dilutant, and can be present in fairly large proportions with no ill effects. Carbon monoxide, having reducing properties, makes a satisfactory condition to a brazing atmosphere. Both of these gases are present in some proportions in the reformed nitro-carbon or city gas, and nitrogen, of course, is present in the dissociated anhydrous ammonia. Installation of copper-brazing furnaces would, in general, include one of these two gas generating equipments, although with the small muffle type furnaces it is often economical to use tanked hydrogen.

Conclusion

In conclusion, it may be said that while copper-brazing from the nature of the process may not be suitable for some classes of work, there are many instances where it far surpasses other ways of mak-

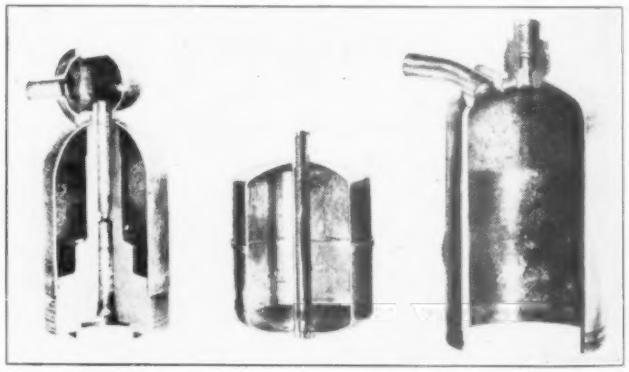


Fig. 8

ing joints, and it makes feasible certain assemblies that would be wholly impracticable by any other means. Economies have often been shown by the process and usually one or more of its features, such as appearance, strength, gas tightness, ductility, good heat conductivity, and so forth, make it particularly desirable for certain applications.

THE NON-FERROUS FOUNDRY

IN CONNECTION WITH TOOL ENGINEERING

By ED. A. RUTT, Factory Manager, Commerce Pattern, Foundry, & Machine Co.

Historians tell us that man's first tools were made of wood and stone. Then came the copper and bronze age, when man first learned to work and alloy non-ferrous metals. Historians generally work on the assumption that primitive and ancient man knew the so-called "lost art of hardening copper," although there is no absolute proof that the ancients did any more than just toughen copper and bronze by cold hammering them.

Then came the iron age, when man learned the art of smelting, working, and alloying iron. Copper and bronze were soon relegated to oblivion as far as their use for weapons and useful tools was concerned. This was due mainly to the superior temper or hardness of steel over bronze. Even until recent years non-ferrous metals were looked upon with disdain by designers of tools, with perhaps the exception of their use for bearings.

Science has made such rapid strides in non-ferrous metallurgy that now the use of non-ferrous metals in tool design cannot be overlooked.

The main element in most non-ferrous metals is copper; therefore, metallurgists have spent a great deal of time in their research work on this metal.

The extensive use of resistance welding machinery has created a large demand for copper, and the foundry men being alert to this demand have developed the casting of copper to such a degree that cast copper now replaces forged copper in most instances. One of the greatest problems in the casting of copper is its natural affinity for oxygen, which is taken up by the metal in its molten state and appears in the finished casting in the form of blow holes. This condition has now been remedied by progressive foundry men, and it is now possible to purchase copper castings with a purity of 99.84 per cent. and a conductivity of approximately 85 per cent. It is a known fact that the castings are made more faithfully to form than forgings. This eliminates much of the expense incurred in machining copper forgings, due to the fact that in a casting machining is necessary only where the contact is made. The fact that a casting can be cored out permits more intricate shapes than forgings; therefore, openings can be cast for water jacketing, which is often necessary on welding machinery.

With these facts in mind, it can readily be seen that castings can be made more economically than forgings. Care must be exercised in selecting a foundry experienced in casting a pure copper of high conductivity or current carrying capacity, because high purity of copper does not necessarily indicate high conductivity, as high current carrying capacity is attained only by casting a metal of great density. Copper castings are now successfully used for transformer secondaries, connecting lugs, plating racks, welder arms, and formed jaws and clamps of welding equipment. There are many cases where current carrying capacity must be sacrificed in preference to hardness or greater tensile strength, and this is attained only by alloying copper with other metals.

Local scientists are now working on the development of a metal named beryllium and its alloys with non-ferrous metals. We expect to publish a separate treatise on this metal in this paper at a later date, but it is interesting to note at this time that copper, alloyed with a small percentage of this metal, can be heat treated, so that it can be used in many places where steel is now being used. Tensile strengths greater than 200,000 lb. per square inch have been reached with this alloy in heat treated form. Its present limitation is its great expense, but there are cases where non-ferrous metals must be used regardless of cost, as in cases where a hard non-magnetic metal is indispensible.

A very well known alloy of copper is aluminum bronze, which is sold under various trade names, and which contains in the neighborhood of 80 to 90 per cent. copper, 10 to 15 per cent. aluminum, and 1 to 5 per cent. iron, according to the degree of hardness required. Hardness as high as 55 scleroscope and tensile strength up to 100,000 lb. per square inch are easily attained. This metal has a very wide use because of these characteristics. Its electrical conductivity is low, the conductivity being about 16 per cent., but this can be somewhat remedied by increasing its cross section where electric current is being carried. It is successfully used for welding fixtures on electric welders and holding fixtures for gas welding, as it is unaffected by the flame of the gas or the cutting torch. Other uses are for bearings subjected to great shock, such as punch press bearings, boring spindle bearings, boring bar pilot

bushings, guide pin bushings, worm nuts, thrust collars, worm gears, and last but not least, draw die sections. Its acid resisting qualities make it a good metal to use on pickling racks, and acid and brine pumps. Non-sparking tools made of this metal, to be used near highly combustible material such as lacquer, gasoline, and explosives, can be purchased in various forms such as spray booth scrapers, wrenches, hammers, cold chisels, shovels, etc. Its weight is the same as that of cast iron, which is about 16 to 20 per cent. less than ordinary bronzes.

Another great servant of the tool designer is manganese bronze. While the average manganese bronze has a tensile strength of about 55,000 lb. per square inch, high tensile manganese bronzes can be purchased that easily reach 95,000 lb. per square inch. Very often, and especially at this time when tool programs start suddenly and "change overs" have to be made quickly, the speed with which nonferrous castings of these characteristics can be procured makes them preferable to steel forgings and steel castings, aside from the fact that these castings come cleaner, have a better appearance, and can be made with a minimum of machine allowance. This applies mainly to small and medium sized castings and forgings such as clamps, toggles, levers, handles, conveyor hooks, wrenches, etc.

Before closing it would be wrong to overlook the great value of aluminum and aluminum alloy castings where lightness is required, as, for example, in portable fixtures and drill jigs, housings for portable transformers and motors, and high speed reciprocating parts.

Thus, it can be readily seen that by overcoming the inherent prejudices against these metals, a nonferrous foundry can be a valuable adjunct to a tool room and machine shop.

It is reasonable to expect that a TOOL DESIGNER knows the machine for which tools are to be made and keeps up-to-date on attachments and small tools through the medium of trade journals and catalogs. Mentally he is equipped to attack a tooling proposition by the most direct and economical method. With fixtures, proper attention will be given to holding, chip clearances, and possible springing of the part. Stock patterns will be used to advantage, clamps will operate speedily, parts will be held in best position for the cutter, and the proper type of cutter will be designed. With designed jigs, bushings will be of the proper length and distance from the work, jigs will not be of excessive weight, and the part will load and eject easily, and dimensions will be given from the toolmaker's point of view. Cut and try methods, adopted in emergencies, often result in demonstrating that haste is waste.

(Copied from the "American Machinist" 8-7-30.)

REPORT OF MEETINGS COMMITTEE

In the past the Meetings Committee has operated in a more or less haphazard and trust-to-luck manner. We have decided that this condition must be remedied, and, as the first step in this direction, have arranged a schedule of meetings and speakers.

Mr. Hoffman, chief tool designer at General Motors Truck, sent out about forty letters to various concerns that might be able to furnish speakers on topics of interest to tool engineers. We have had favorable answers to most of these letters, with the result that we take pleasure in announcing the following schedule of meetings dates and speakers:

September 8	Mr. Smith, Lo Swing Co. Mr. D. A. Campbell, Pratt & Whitney Co.
October 13	Mr. Parker Holden, Parker Holden Co.
November 10	Mr. Furst, Western Electric Co. A speaker from Norton Co.
December 8	Mr. Batcholts, General Electric Co. A speaker from Timken Bearing Co.

The Committee can arrange for banquets and entertainments on comparatively short notice on regular meeting nights. It will be left to the discretion of the Board of Directors as to whether it is advisable to have meetings at which admission must be charged.

Most of the speakers we have contracted will speak on technical subjects, and as we should like to have one speaker at each meeting to speak on general subjects, we would appreciate any help from the membership in finding suitable speakers. Talkers capable of injecting humor into their talks are especially desired.

Anyone having any help to offer in this matter may get in touch with me, or send it in to the office at 8316 Woodward Ave.

EARL J. RUGGLES,
Chairman of the Meetings Committee.

Tool Engineering Bulletin No. 3

POWER REQUIRED FOR DRILLING

When laying out new machining operations or when buying new drilling equipment for a given purpose, it is often desirable, to know, at least approximately, the power required to operate twist drills.

The data given below is intended as a ready reference. Those wanting further details we refer to the paper "Torque, Thrust and Power for Drilling" in the S. A. E. Journal of March 1931, where formulas and further data are found.

The figures given below represent power required for drilling materials of average machinabilities. The feeds given are those recommended for the sizes of drills shown. An allowance of 20%, for machine friction, has been made. For the sake of clearness, no allowance has been made for the dulling of drills. In practice, at least 50% should be added to care for this.

Diameter of Drill	Feed per Revolution	H.P. for Steel at 60 Ft. Speed	H.P. for Cast Iron at 100 Ft. Speed
1/2"	.010	.34	.26
5/8"	.011	.52	.40
3/4"	.012	.77	.59
7/8"	.013	1.06	.80
1"	.014	1.40	1.06
1-1/8"	.015	1.88	1.42
1-1/4"	.016	2.42	1.83
1-3/8"	.016	2.86	2.16
1-1/2"	.016	3.22	2.44

Courtesy of C. J. Oxford.

National Twist Drill & Tool Co.
Detroit, Mich.

Tool Engineering Bulletin No. 4

THRUST LOADS ON TWIST DRILLS

We are frequently asked how much pressure is required to feed a Twist Drill of a given size when drilling Steel or Cast Iron. Drill press designers and builders have been interested in this question for a long time, but with the recent introduction of hydraulic feeding means for many machining operations, the subject has become of more general interest.

Feeding pressure should not be confused with horse power required to drive the drill. It has been found that less than one percent (1%), of the total power applied in drilling, is used to overcome the resistance due to feeding pressure.
Readers who are interested in securing additional information on the subject are referred to the S.A.E. Journal for March 1931 where formulas and additional data are given.

The data given below represents average conditions, and should be used only as a general guide at the feeds and speeds given. It applies for sharp drills of standard construction, and with standard web thickness. Experience has shown that the feeding pressure will increase at least fifty percent (50%) over the figures given before a drill can be said to be excessively dulled.

Diameter of Drill	Feed Per Revolution	Thrust or Feeding Pressure. Drilling Steel	Drilling Cast Iron
1/2"	.010	750 lbs.	200 lbs. approx.
5/8"	.011	1000 "	275 " "
3/4"	.012	1275 "	325 " "
7/8"	.013	1590 "	400 " "
1"	.014	1910 "	500 " "
1-1/8"	.015	2275 "	600 " "
1-1/4"	.016	2650 "	700 " "
1-3/8"	.016	2925 "	775 " "
1-1/2"	.016	3200 "	850 " "

Courtesy of C. J. Oxford.

National Twist Drill & Tool Co.
Detroit, Mich.

EDITORIAL PAGE

THE ART OF METAL-WORKING

The basic foundation of this modern civilization is man's conquest over metal, his ability to form and cut them, to make the machines so necessary in the manufacture of almost every consumable product to-day. Comparatively few people realize the importance of machine tools and metal cutting tools in the vast complex industrial structure of to-day. This ignorance is really lack of information, and due to abhorence of the subject, because of the inability of writers to avoid making writings on the subject dry and heavy.

There is a lot of romance in this subject that is waiting for exploitation, in fact, enough to inspire any artistic soul, should he care to view the subject in the proper light. There is just as much art in metal-cutting and forming as in the reproduction of images on canvas or in stone. The majesty and beauty of architecture, when one opens his eyes to it, can't be said to hold much over the machines and the operations involved in the many complex phases of metal-forming. It is said that real art lives. Is there anything more imbued with life than the busy metal-working machine engaged in the making of a needed or useful item of modern living? The layman witnesses the motor car, the railroad train, the aeroplane, the ocean liner, and man's conquests over time and space, but what about the just as wonderful means of producing these wonders?

Art has not been neglected in this modern civilization, as many are wont to claim. It has merely found new channels and fields of expression, and the so-called artists and those appreciative of art have failed to grasp this truth. It is possibly because this art has been surrounded by rather unattractive conditions, both physical and mental, that it has been unappreciated. One wonders if those who labored on the Pyramids and the ancient Grecian temples appreciated the artistic significance of them, or was it necessary for us of this age to see them from a distance to really appreciate them, both as to artistry of expression and appearance?

Is it possible that those in daily contact with the modern art of metal-working have their noses too close to the picture to appreciate it? On the other hand, does it seem logical that those not in contact are inappreciative because of lack of knowledge or comprehension of what is going on all around them? Our universities give courses in "Appreciation of Art." The purpose of these courses is apparent from the title. It is significant to note that they are recommended for engineers, because, as you might expect, of the often-heard criticism that engineers are too lacking in cultural education. Could it be possible that those having a cultural type of education are lacking in "Appreciation of Engineering"? Why not include courses in our universities in "Appreciation of Engineering" for those seeking a cultural, liberal, political, or even commercial education? Included in these courses would be a no small part devoted to the appreciation of the Art of Metal-Working.

In addition to this, there is a lot of work that can be done to bring a realization to those in daily contact with metal-working an appreciation of the artistic phases and expressions of this great division of modern life. It should result in a more genuine satisfaction in their work, and a relief from the attitude of drudgery which is largely mental. There is romance in the most monotonous factory occupation, if one looks for it and is taught to see. As for engineers, with their education and intellect, the opportunities for a more genuine and substantial appreciation of their work are almost without limit. It is remarkable, the inspiration and happiness that can result from an appreciation of this sort. Try it if you are skeptical.

This art we have been discussing is the art of purpose, expression, and effect. The Art of Metal-Working, to which we refer in the following, is based upon that definition of art, as compared with science. There has probably been more accomplished, with less actually known about the subject, in metal-working than in any other phase of engineering. At the same time, it is logical to expect, and it is true, that this accomplishment has not taken place without a certain amount of definite and scientific knowledge of the subject. We are particularly interested at this time in the proportion of art to science in the field of Machine Shop Practice and Metal-Cutting.

There is a definite effort being put forth by various engineers and institutions of engineering to set up Metal-Cutting as an exact science. The problem is not beyond our mental faculties, but the expense involved, the patience required, and the lack of immediate financial returns are all factors of a deterring nature. It would be commendable for the government or some philanthropic individual to appro-

priate a sum sufficient to carry on an intensive research in the field of Metal-Cutting. The project could not be expected to be a profit-making one. It should not be undertaken as such, as this attitude would not be conducive to best results. A work of this nature would be monumental, and for best results should be consolidated.

Past works have been carried on by a comparatively large number of engineers and institutions. The results of these investigations when gathered together form a rather impressive, if incomplete, supply of useful data, for the Tool Engineer in particular. In addition to this data, there are a lot of empirical formulae and rules-of-thumb now in use by practical shop-men and machine-tool builders that are not generally known that would also be very welcome and useful to the Tool Engineer.

Is there a more appropriate institution to sponsor such a study of Metal-Cutting than the American Society of Tool Engineers? This would not necessarily involve the expenditure at present of any money for research work, although this could be undertaken later as the Society grows. At present the work could be limited to a collection and compilation of all available existing data on the subject under a series of articles in the Society's Journal. These articles should be printed on perforated sheets to facilitate filing of the subject matter. At the conclusion of the initial series of articles, additional articles should be published in the same manner to keep pace with developments on the subject. By using a loose-leaf note book, properly indexed, any member can easily obtain and maintain an up-to-the-minute source of information on this subject.

Why guess any more than necessary in the solution of tool engineering problems? Let's start now to appreciate the art of Metal-Cutting, but try to use it as a science.

NEWS NOTES OF THE INDUSTRY

Ford Motor Company of Canada, Ltd., has started shipment of its first V-8 models to Ford Motor Company, Ltd., of England. In June an agreement was reached whereby Canadian Ford will supply between 18,000 and 20,000 Ford V-8 completed cars to the English company in a year. The Canadian company in return will take approximately 3,600 eight horse-power Ford cars (recently announced) for markets in its export territories.

A gain of 44.9 per cent. in Rockne deliveries by dealers in 85 key points of the U. S. during the second ten days in June over the first ten days in June was announced by George M. Graham, Vice President of Rockne Motors Corporation.

Machine tool orders, considered a good indication of the trend of industry, decreased in June from the previous month, although they gave further evidence that business is running along the bottom. The June figures, compiled by the National Machine Tool Builders' Association, based on 1922-1924 as equal to 100, was 37.2 compared with 38.9 in May and 32.6, the low for the depression, reached in March 1932.

The stability shown in recent months, plus the present low level, provides the basis for encouragement which may result in an upturn this fall.

On the basis of the above index, orders at the peak (in February and March, 1929) were approximately 335.

Since it has inaugurated its new merchandising program, Auburn shipments during the past six weeks have jumped 273 per cent. over the previous six week period.

Although employment in the automobile industry decreased only one-tenth of one percent. in June under May, according to the figures of the U. S. Bureau of Labor Statistics, the pay roll dropped 12.1 per cent., in reflection of the slowed operation of many plants.

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PERSONALS

Heard at a meeting of the Board of Directors:

CHAIRMAN SIEGEL: "..... and I admonish you all to use fearless but fair judgment when balloting on these applicants for membership in the society. White balls elect, and black balls reject.

SEC'Y. SARGENT: "The black balls are square."

Mr. D. W. Ovaitt (member) of Flint, Mich., having resigned from the Buick Motor Co., is now organized in private practice as consultant in factory management and efficiency. The A.S.T.E. and his many friends wish him every success in this field where he has occasioned many advancements, especially in the automotive, machinery, and tool industries.

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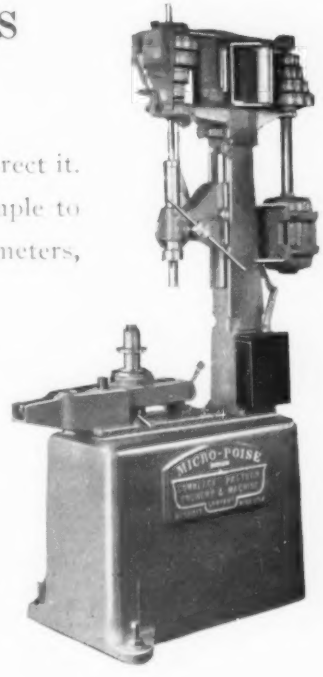

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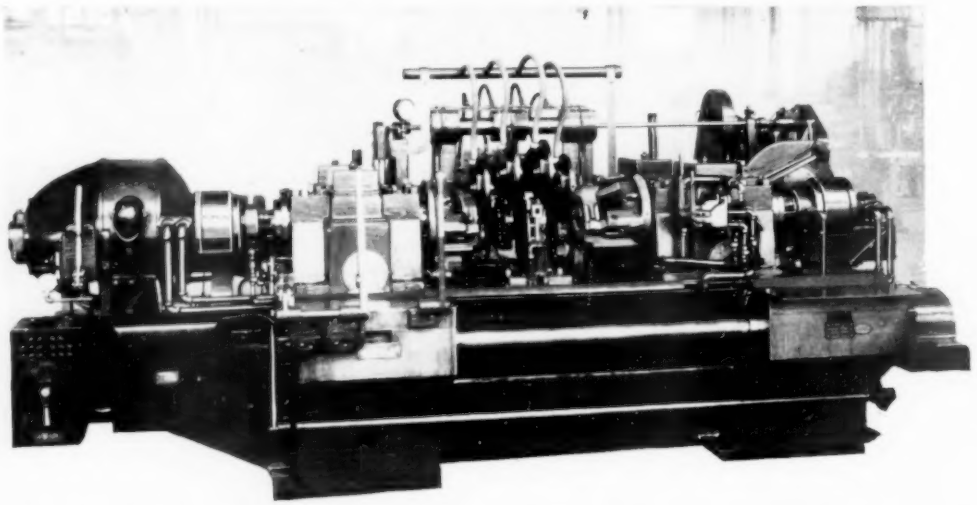

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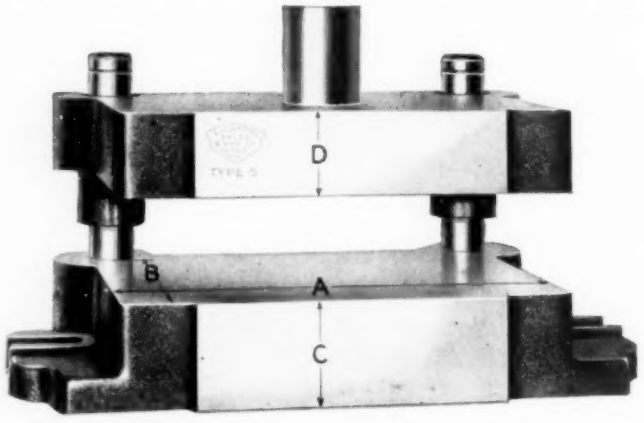

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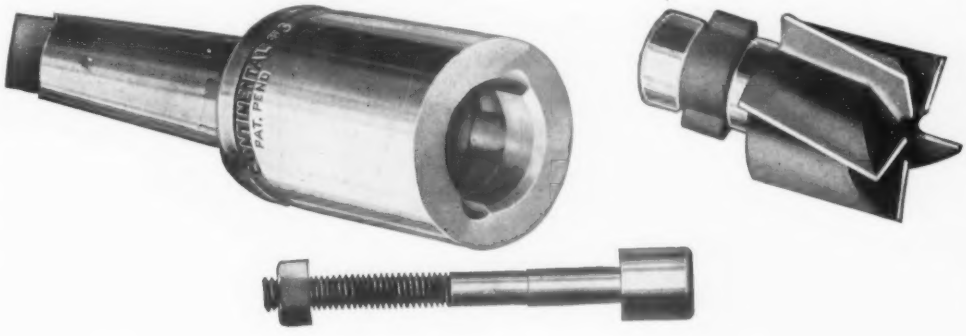

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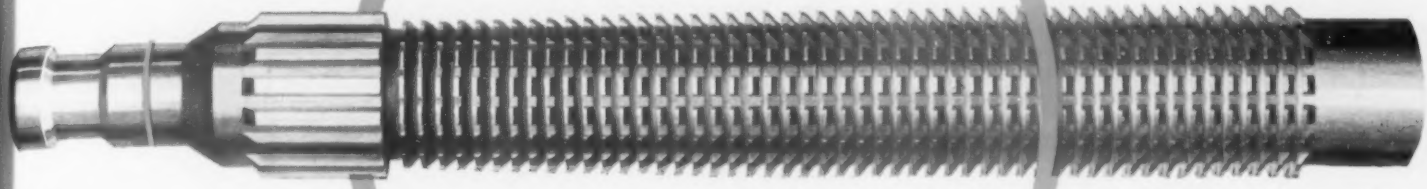

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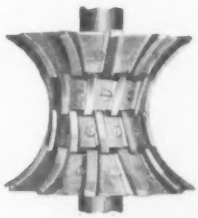

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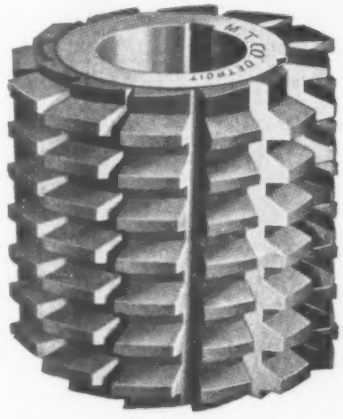

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